# REPORT OF MARY DUNN BAKER, Ph.D.

*VIVIAN BERT, et al., v. AK STEEL*

**UNITED STATES DISTRICT COURT**
**SOUTHERN DISTRICT OF OHIO**
**WESTERN DIVISION**

**CASE NO. C-1-02-467**

**Judge Sandra S. Beckwith**
**Magistrate Judge Timothy S. Hogan**

**ERS Group**
**Tallahassee, Florida**
**May 25, 2005**

## I. INTRODUCTION

***Assignment.*** At the request of Counsel for AK Steel (the Company), I was asked to review and evaluate Dr. Edwin L. Bradley's April 18, 2005 report entitled "Supplemental Expert Report Regarding Hiring Into Laborer Positions at Middletown Works and Ashland Works of AK Steel." In addition, I was asked to prepare my own statistical analyses of the Company's relevant hiring decisions, if appropriate.[1]

***Summary of Dr. Bradley's Opinion.*** In his report, Dr. Bradley describes the results of his analyses of the racial composition of Middletown laborer[2] hires who applied during the period 1/1/2000 - 10/29/2003 and Ashland laborer hires who applied from 10/24/2000 - 9/17/2002. Based on these analyses, he asserts that AK Steel hired statistically significantly fewer African-Americans than would be expected if the hiring process was neutral with respect to race.

***Summary of My Opinion.*** In my opinion, Dr. Bradley's Middletown and Ashland analyses produce misleading results because he:

- includes applicants and hires who applied and who were hired into laborer jobs prior to the relevant study period for this case;[3] and
- uses an inappropriate statistical method.

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[1] This report is based on the information available to date. Should additional data become available or other issues arise, I may revise or supplement this report.

[2] Laborer is the entry-level position for all bargaining unit jobs in the Middletown and Ashland steel mills. Laborers work in all parts of both mills, doing many different types of jobs. Some of the laborer tasks are complex and are performed in a potentially hazardous environment. Because the consequences of poor performance can be dire, hiring qualified applicants is key to ensuring the safety of the Company's employees.

[3] Counsel for AK Steel advised me that the start date for the relevant study period is August 12, 2001.

His Ashland analysis is further flawed because he did not correctly count the number of applicants for and hires into Ashland laborer jobs. Specifically, he

- did not count as hired some Ashland applicants who were, in fact, hired into laborer jobs during the time period that he studied; and
- includes some applicants who were not considered for laborer jobs, but who were hired into skilled positions such as crane operator and electrician.

In addition, the shortfall that Dr. Bradley's Middletown analysis yields is exaggerated because he includes some applicants who could not have been hired by AK Steel. Specifically, he includes Middletown applicants who:

- withdrew from the hiring process on their own accord; and
- would have been hired, but became ineligible for hire after they failed to successfully complete the background check or the physical exam.[4]

Analyses do not reveal a statistically significant pattern of under-hiring African-Americans for laborer positions when the study covers the appropriate time period, uses the appropriate statistical technique, excludes Ashland applicants who were hired into non-laborer positions, uses the correct number of Ashland laborer hires and considers the fact that some Middletown applicants were not hired because they withdrew from the

[4] At page 9 of his report, Dr. Bradley states that he "cannot analyze separately the components of the selection procedure used for hiring into the Laborer positions at AK Steel" because, at deposition, Ms. Lester and Ms. Short indicated that they did not have complete information about the results of the screening process, reasons why an applicant did not take the test, etc. While documentation regarding the various stages of the hiring process is not available for Ashland, the Middletown documents provided to Dr. Bradley do contain information sufficient to conduct analyses of each step of this facility's hiring process. The Middletown documentation includes the results of the screening process and information about who did and did not take the test, as well as the test result for test-takers. It includes information about who was and was not interviewed and the result for those who were interviewed. The Middletown documentation also shows who was and was not referred for a background check and physical exam and the outcomes of these steps. Furthermore, the Middletown documents allow for the identification of applicants who withdrew and when they withdrew from the hiring process. The fact that Ms. Short (AK Steel General Manager of Human Resources, previously Middletown Human Resources Manager) did not have personal knowledge of such things as the reason that an applicant failed to take the test does not mean that Middletown data are not sufficiently complete to analyze each stage of this facility's hiring process.

hiring process or became ineligible for hire. In fact, such studies show that the outcome of AK Steel's laborer hiring is consistent with the result of the race-neutral model.

***Credentials.*** I am a labor economist with extensive experience in statistical analyses of employment practices and in the computation of economic loss estimates. I completed the Ph.D. in Economics at Florida State University in 1986. Since July 1986, I have been employed by Economic Research Services Group (ERS) in Tallahassee, Florida. ERS is a research and consulting firm whose professionals work with individuals, government agencies, colleges and universities, corporations and other organizations to analyze employment decision-making processes and to compute estimates of the value of alleged economic losses. I have testified in federal courts and other judicial settings about statistical analyses and economic loss estimates that I have prepared on behalf of both plaintiffs and defendants. For the last several years, I, along with other Ph.D. economists at ERS, have presented seminars on the economics and statistics of employment discrimination and the computation of the value of losses resulting from a variety of events and actions. State bar associations offer continuing legal education credit for attending the ERS seminars. In addition, on many occasions, I have been invited by organizations such as the Florida Bar Association, the American Association for Affirmative Action and the U.S. Department of Labor's Office of Federal Contract Compliance Programs (OFCCP) to give lectures and conduct workshops on statistical analyses of employment issues and the valuation of economic losses. Appendix A provides an outline of my credentials and the cases in which I have given testimony over the last four years.[5]

[5] ERS charges $350 an hour for the time that I spend on this matter and $90 - $300 per hour for the services that my staff provides.

## II. DATA AND DOCUMENTS

In addition to Dr. Bradley's report, the primary data and documents upon which I relied to prepare this report are outlined below.

1. Complaint – Class Action filed on June 26, 2002;
2. An electronic Ashland applicant flow log [Ashland Summation Database (W0425161).XLS];
3. An electronic list of new hires into laborer positions at Ashland [april25fileofnewhires8a8bforattorney.xls];
4. A DVD containing scanned images of Ashland employment applications;
5. An electronic Middletown applicant flow log [Database for Mary Baker (W0389100).XLS];
6. Nine CDs containing scanned images of Middletown employment applications;
7. A revised electronic Middletown applicant flow log [AK Bert Middletown Data Base (W0423915).XLS];
8. An electronic list of new hires into Middletown laborer jobs [HIRE.DATA.XLS];
9. 'pdf files containing scanned images for three new Middletown laborer hires whose names were not shown on the applicant flow log [mcintyre.pdf, sweet.pdf, and washingt.pfd];
10. The transcripts of the February 16, 2005 depositions of Ms. Phyllis Short (AK Steel General Manager for Human Resources, previously the Middletown Manager of Human Resources) and Ms. Susan Lester (Ashland Manager of Human Resources);
11. An electronic file containing the zip codes of the currently active Ashland union employees [tackashlandhourly042505.xls];[6]
12. 2000 Census data regarding the racial composition of individuals who work in laborer and helper jobs (EEO-1 category 8) in the Huntington-

[6] The zip codes were used to identify the counties in which the Ashland union employees live.

Ashland Metropolitan Statistical Area (MSA)[7] and the counties in which the Ashland laborer hires live;[8]

13. Use of Statistics in Equal Employment Opportunity Litigation by Connolly, Peterson, Connolly and Zesch published by the Law Journal Press (2004 edition); and

14. The Statistics of Discrimination, Using Statistical Evidence in Discrimination Cases by Paetzold and Willborn (Clark, Boardman, Callaghan, 1996).

The analytic files that ERS constructed to prepare the Ashland and Middletown analyses described herein were compiled using items 2 - 9, as well as the Company's responses to data questions.[9]

## III. CONCEPT OF STATISTICAL SIGNIFICANCE

In a race-neutral hiring process, the expectation is that African-American applicants will be selected for laborer positions in proportion to their representation among applicants for the job, assuming that African-American and non-African-Americans are similarly situated in all relevant respects (such as possessing comparable qualifications and pursuing the hiring process with equal diligence). Therefore, the expected number of African-American laborer hires is computed by multiplying the total number of selections by the percent African-American among similarly situated applicants.[10]

If the actual number of African-American hires falls short of the predicted number, then the number of standard deviations of the difference is computed to

[7] The Census data for the Huntington-Ashland WV-KY-OH MSA is provided at Appendix B.
[8] The Census data for Laborers and Helpers in the relevant counties is provided at Appendix C.
[9] The analytic files differ from the electronic applicant data files provided because erroneous entries were corrected and missing data elements were entered where possible. For example, erroneous race codes were corrected and some missing race codes were entered.
[10] If the applicants included in the analysis are not similarly situated, then the demographic group availability rate and the expected number of selections will be erroneous.

determine whether the observed difference is "too large" to be consistent with the race-neutral outcome. Generally, social scientists and the courts conclude that when the actual number of African-American selections falls approximately two [technically, 1.96] or three standard deviations short of the expected number, the observed difference is not likely to be attributable to random variation in a neutral environment.[11] Such differences are considered *statistically significant* and generally provide statistical support for the allegations of discrimination (provided that the applicants are similarly situated in all relevant respects and the model reflects the reality of the decision-making process).[12]

When the actual number of African-American hires is within two or three standard deviations of the expected number, social scientists and the courts typically conclude that the difference is likely to be attributable to chance and that the outcome is consistent with the race-neutral result. Differences that are less than two or three standard deviations are considered *statistically insignificant* and fail to provide statistical support for allegations of discrimination.

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[11] For examples of courts' interpretations of the results of statistical analyses, see *Hazelwood School District v. United States* [433 U.S. 299; 97 S.Ct. 2742 (1977)] and *Palmer v. Shultz* [815 F.2d 84, 97 (D.C. Cir. 1986)]. In Dr. Bradley's opinion, the threshold for statistical significance is 1.645 standard deviations, rather than 1.96, or approximately two. In the *Palmer* opinion, the court explains why the "two or three standard deviation rule" should be used for purposes of determining statistical significance. This issue is also discussed in Use of Statistics in Equal Employment Opportunity Litigation by Connolly, Peterson, Connolly and Zesch. Appendix D provides the relevant excerpt from this text.

[12] Statistically significant differences may be caused by non-racial factors for which the analysis did not account. This will occur when the demographic groups whose outcomes are compared are not similarly situated. The importance of considering other non-racial factors when interpreting the results of statistical analyses is addressed in The Statistics of Discrimination, Using Statistical Evidence in Discrimination Cases by Paetzold and Willborn. Appendix E provides the relevant excerpt from this text.

## IV. FLAWS IN DR. BRADLEY'S ANALYSES OF LABORER HIRES BY RACE

The time period covered by Dr. Bradley's analyses begins on January 1, 2000. According to Counsel for AK Steel, the start date of the relevant study period in this case is August 12, 2001. Therefore, Dr. Bradley's analyses include some hiring decisions that were made prior to the relevant time period.

Dr. Bradley used the hypergeometric method to compute the number of standard deviations between the actual and expected number of African-American hires. This method is appropriate when the actual applicant pool for each selection (or set of selections)[13] is known and the analysis is conducted on a decision-by-decision basis (to account for variation in the racial composition of applicant pools from one point in time to another). While actual applicant data are available for the period that he studied, the particular applicants who were actually considered for each vacancy (or set of vacancies) is unknown.[14] Because Dr. Bradley used the percent African-American among all applicants of known race who applied at Middletown over the period 1/1/2000 - 10/29/2003 and who applied at Ashland during the period 10/24/2000 - 9/17/2002 as an approximation of African-American availability for each vacancy (or set of vacancies) at the respective facilities, his choice of the hypergeometric method to analyze the data is inappropriate. Instead, he should have used the binomial method.[15]

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[13] "Set" of selections or vacancies refers to specific points in time at which more than one hiring decision was made.

[14] Therefore, the analyses cannot be conducted on a vacancy-by-vacancy basis.

[15] The binomial method should be used when a proxy for a demographic group's availability rate for a given selection is used.

Another reason that the binomial should be used in this case is that the race of some applicants is unknown. The assumption underlying Dr. Bradley's analysis is that the racial composition of applicants of unknown race is approximately the same as the percent African-American among applicants of known race. According to Dr. Bradley's report, the race of 4.2% (6.4%) of the Middletown (Ashland) individuals who applied during the time frame that he studied is unknown.

In his analysis of Ashland hires, Dr. Bradley includes some applicants who were hired into positions other than laborer such as crane operator and electrician. As these applicants were not considered for laborer jobs, they should not be included in the analysis.[16]

Moreover, as Dr. Bradley's Ashland analysis does not include applications that were submitted after September 17, 2002, he did not use all of the available Ashland data for the relevant time period. In his report, Dr. Bradley states the applications with dates after September 17, 2002 could not be used for analysis because it was not clear who among these applicants was ultimately hired and the race of more than 30% of the applicants was unknown.[17]

In my opinion, the post-September 17, 2002 Ashland applicant data can be used for analysis for two reasons. First, AK Steel can identify new hires into Ashland laborer positions.[18] Via the Company's response to a request to provide a list of new hires into Ashland laborer jobs over the time period for which application data was produced, ERS was able to identify the applicants who were actually hired into relevant jobs.

Second, while the race of more than 30% of the individuals who applied at Ashland after September 17, 2002 is unknown,[19] in this case, my opinion is that the race data that are available should not be ignored as there is no reason to believe that the use of this information would result in an understatement of African-American representation among applicants for these jobs. As shown below, the percent African-American among the individuals of known race who applied for an Ashland laborer job during the period

[16] I am informed that rejected applicants for skilled positions were considered for laborer jobs.
[17] See page 7 of Dr. Bradley's Supplemental Expert Report.
[18] At deposition, Ms. Lester testified that she could provide a list of all laborers who were hired since January 2000.
[19] See page 7 of Dr. Bradley's report.

August 12, 2001 - December 31, 2003 is 4.6%. This African-American availability rate is substantially higher than the percent African-American among individuals who work in laborer jobs in the relevant local labor market.[20] According to the 2000 U.S. Census, African-American representation among workers in laborer occupations in the MSA in which Ashland is located is 2.00%.[21] African-American representation among laborers in the counties in which most of the Ashland union employees live ranges from 0.00% to 1.42%.[22] Given these local labor market availability rates, the use of the Ashland applicant race data that are available is not likely to understate the rate at which African-Americans actually applied for these jobs.

Dr. Bradley's Middletown hiring analysis includes all applicants of known race who applied for a laborer job. Middletown documents show that some of these individuals withdrew their applications during the hiring process.[23] As individuals who voluntarily withdrew from the hiring process could not have been hired, these applicants should be excluded from the analysis. His inclusion of applicants who withdrew results in an exaggeration of the magnitude of the Middletown shortfall in African-American hires.

The Middletown data and documents also identify the applicants who were referred for a background check. According to Ms. Short's deposition testimony:

- applicants who passed the background check received a conditional offer of employment and those who passed the physical exam were hired; and

[20] In the absence of actual race data, labor economists often estimate the availability of a demographic group for an occupation (or set of occupations) using U.S. Census data for the relevant local labor market.
[21] Ashland is located in the Huntington-Ashland, WV-KY-OH MSA. See Appendix B.
[22] Ashland's union employees live in 17 different counties. Nearly 80% of these live in Boyd County, KY, Carter County, KY, Greenup County, KY and Lawrence County, OH. See Appendix C.
[23] Ashland applicants who voluntarily withdrew from the hiring process cannot be identified.

- those who did not complete or pass the background check or the physical exam were not eligible for hire.

Although Dr. Bradley had the data to determine which Middletown applicants were referred for a background check and a physical exam, he chose not to consider this important information.[24] Therefore, in his Middletown analysis, some of the unsuccessful applicants were not eligible for hire because they did not pass the background check or the physical exam. Because African-American applicants who were subject to the background check and/or the physical exam were less likely than others to successfully complete these steps, his failure to consider this phase of the hiring process results in an inflated Middletown shortfall in African-American hires.

## V. ALTERNATIVE ANALYSES OF THE RACIAL COMPOSITION OF LABORER HIRES[25]

***Ashland Analysis.***[26] As Table 1.a shows, during the period August 12, 2001 - December 31, 2003, 1,080 applications were submitted for Ashland laborer jobs by individuals of known race. Forty-nine (or 4.5%) of these applications were presented by African-Americans.[27]

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[24] The Ashland data do not allow for the identification of applicants who were referred for a background check or physical exam.

[25] All of the analyses described in this section are conducted using the binomial method. Duplicate applications are excluded from the analyses.

[26] The Ashland analysis excludes 45 duplicate applications, 821 applications submitted by individuals of unknown race and 109 applicants who were hired into skilled positions.

[27] At Table 1-A in his report, Dr. Bradley shows that the percent African-American among Ashland applicants for the period 10/24/2000 - 9/17/2002 is 8.65%. Apparently, his analysis was conducted using the Ashland data initially provided. Subsequently, additional Ashland data were produced. My research using all of the available Ashland data indicates that approximately four percent of the individuals who applied for laborer jobs during this period are African-American. This African-American representation rate is similar to the percent African-American among those who applied after September 17, 2002.

Ashland hired 115 of these applicants into laborer jobs. Therefore, the expected number of African-American hires is approximately five (5.2 = 115 x 0.045). Table 1.a reveals that nine of the hires are African-American, or approximately four more than expected. Clearly, the Ashland data available for the relevant time period do not provide statistical support for the allegation that the Company under-selected African-Americans for these laborer jobs during the relevant time period.[28]

***Middletown Analyses.***[29] Table 1.a shows that, over the period August 12, 2001 - December 31, 2003, 4,084 applications for Middletown laborer jobs were presented by individuals of known race and were not withdrawn during the hiring process.[30] Approximately 8.9% (364) of these applications were submitted by African-Americans.

During this period, Middletown hired 417 laborers. Therefore, the statistical expectation is that approximately 37 (37.2 = 417 x 0.089) of these hires would be African-American. The data show that 25 of the 417 hires are African-American, or about 12 fewer than predicted. As the number of standard deviations of this difference is -2.09, this 12 person shortfall exceeds two, but not three, standard deviations.[31] Had

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[28] This analysis includes all *applications* (excluding duplicates) presented by individuals of known race during the study period. Some applicants submitted multiple applications during the relevant time frame. Table 1.b reports the results of an analysis of the racial composition of Ashland laborer hires that includes only one application per person. As Table 1.b shows, this analysis also reveals that Ashland hired a larger number of African-Americans than would be expected given their representation among applicants.

[29] The Middletown analyses exclude 175 duplicate applications, 205 applications submitted by individuals of unknown race and 322 applications that were withdrawn. During the study period, nearly ten percent of African-American applications were withdrawn, while only approximately seven percent of the applications submitted by others were withdrawn.

[30] The 4,084 includes applications that were "screened out" by AK Steel and applications submitted by individuals who did not pass the test; were not interviewed; did not pass the interview; and failed the background check or the physical exam.

[31] This analysis includes all *applications* (excluding duplicates) presented by individuals of known race that were not withdrawn during the hiring process. Table 1.b reports the results of an analysis that includes only one application per person. As Table 1.b shows, this analysis reveals that the difference between the actual and expected number of African-American hires is more than two, but not three, standard deviations.

Middletown hired one additional African-American, the number of standard deviations of the shortfall would have been less than two.

As discussed below, approximately 1/3 of the observed Middletown shortfall is attributable to the fact that a larger percentage of African-American applicants than others became ineligible for hire because they did not pass the background check or the physical exam. As explained above, applicants who passed the interview were subject to a background check. Those who passed the background check were given a conditional offer of employment and were hired if they subsequently passed the physical exam. Therefore, if African-American applications are referred for a background check in numbers consistent with their representation among all applicants who did not withdraw prior to the background check step, then any significant difference between the actual and expected number of African-American hires is the result of African-Americans withdrawing applications after the background check or failing the background check or physical exam at a higher rate than others.

As Table 2.a shows, the Middletown data reveal that there were 4,125 applications that had not been withdrawn prior to the background check step.[32] [The 4,125 includes the applications that were "screened out" by AK Steel, as well as applications that were submitted by individuals who did not pass the test, who were not interviewed and who did not pass the interview.] Out of the 4,125, 728 were referred for a background check.[33] Since approximately 8.9% of these 4,125 applications were submitted by African-Americans, the expectation is that about 65 (64.8 = 728 x 0.089) of

[32] This number of applications (4,125) is larger than the number shown on Table 1.a (4,084) because some of the 4,125 applications were withdrawn after the background check step.
[33] This analysis includes Middletown applicants who withdrew after being referred for a background check and excludes those who withdrew before this point in the hiring process.

the applications referred for a background check would belong to African-Americans. In fact, 57 of the applications that were subject to a background check were from African-Americans, or about eight fewer than expected. As the number of standard deviations of this difference is less than two (-1.01), this outcome is reflective of the result of a process that is neutral with respect to race.[34] Accordingly, the slightly more than two standard deviation Middletown hiring shortfall is explained by the fact that African-Americans were more likely than others to fail the background check and physical, and, as a result, to become ineligible for hire.

***Aggregation of the Results of the Ashland and Middletown Analyses.*** Table 1.a shows that when the results of the Ashland and Middletown hiring analyses are aggregated, the expected number of African-Americans selected during the period August 12, 2001 - December 31, 2003 is approximately 42. The number of African-Americans actually selected was 34, or about eight fewer than expected. As the number of standard deviations of this eight person shortfall is -1.35, this difference is not statistically significant. Therefore, the AK Steel data fail to reveal a pattern of under-selecting African-Americans for laborer jobs during the relevant time period.

Furthermore, as Table 2.a shows, the aggregation of the results of the Ashland hiring analysis and the Middletown analysis of selections for the background check shows that, over the relevant time period, the aggregate shortfall in African-American hires is approximately four. As the number of standard deviations of this four person shortfall is -0.50, this difference is not statistically significant. Again, the AK Steel data

[34] This analysis includes all *applications* (excluding duplicates) that were submitted by individuals of known race and that were not withdrawn prior to the background check phase of the hiring process. Table 2.b reports the results of an analysis that includes only one observation per person for applicants who did not withdraw prior to the background check phase of the hiring process. As Table 2.b shows, the African-American shortfall in referrals for the background check is not statistically significant.

fail to reveal a pattern of under-selecting African-Americans for laborer jobs during the relevant time period.

## VI. SUMMARY

The results of Dr. Bradley's analyses are not helpful to the fact-finder in this case because he includes successful and unsuccessful applicants who applied prior to the relevant time period; used an inappropriate statistical method; did not correctly count Ashland laborer hires; and ignored the fact that some Middletown applicants voluntarily withdrew from the hiring process or became ineligible for hire because they did not successfully complete the background check or the physical exam. Analyses that include applications submitted during the period August 12, 2001 - December 31, 2003; use the appropriate statistical method; correctly count Ashland applicants and laborer hires; and consider the fact that some Middletown applicants could not have been hired because they withdrew or did not pass the background check or physical exam; show that the outcome of AK Steel's laborer hiring decisions is consistent with the result of a race-neutral hiring process. The data reveal that, at Ashland, a larger number of African-Americans were hired into laborer positions than would be expected. At Middletown, the slightly more than two standard deviation shortfall in laborer hires is explained by the fact that African-Americans were more likely than others to become ineligible for hire at the background check or physical exam phase of the hiring process. Accordingly, when the results for Ashland and Middletown are aggregated, the data fail to reveal a significant pattern of under-selecting African-Americans for laborer jobs. Therefore, the results of these analyses do not provide support for Plaintiffs' allegation that African-

Americans were hired for laborer jobs in significantly fewer numbers than expected in a race-neutral setting.

Mary Dunn Baker, Ph.D.

May 25, 2005
Date

## Table 1.a
## Analysis of the Racial Composition of Laborer Hires
## All Applications Submitted August 12, 2001 - December 31, 2003

| Location | Total Number of Applications with Known Race | Number of African-American Applications | Percent African-American Among Applications | Total Number of Hires | Expected Number of African-American Hires | Actual Number of African-American Hires | Difference Between Actual and Expected | Binomial Number of Standard Deviations |
|---|---|---|---|---|---|---|---|---|
| Ashland[1] | 1,080 | 49 | 4.54% | 115 | 5.22 | 9 | 3.78 | 1.69 |
| Middletown[2] | 4,084 | 364 | 8.91% | 417 | 37.17 | 25 | -12.17 | -2.09 |
| | | | | 532 | 42.38 | 34 | -8.38 | -1.35 |

[1]The Ashland analysis excludes 45 duplicate applications, 821 applications submitted by individuals of unknown race and 109 applications submitted by individuals who were hired into non-laborer positions.

[2]The Middletown analysis excludes 175 duplicate applications, 205 applications submitted by individuals of unknown race and 322 applications that were withdrawn during the hiring process.

## Table 1.b
## Analysis of the Racial Composition of Laborer Hires
## Applications Submitted August 12, 2001 - December 31, 2003
## One Application Per Applicant

| Location | Total Number of Applicants with Known Race | Number of African-American Applicants | Percent African-American Among Applicants | Total Number of Hires | Expected Number of African-American Hires | Actual Number of African-American Hires | Difference Between Actual and Expected | Binomial Number of Standard Deviations |
|---|---|---|---|---|---|---|---|---|
| Ashland[1] | 1,006 | 46 | 4.57% | 115 | 5.26 | 9 | 3.74 | 1.67 |
| Middletown[2] | 3,749 | 337 | 8.99% | 417 | 37.48 | 25 | -12.48 | -2.14 |
| | | | | 532 | 42.74 | 34 | -8.74 | -1.40 |

[1]The Ashland analysis excludes 789 applicants of unknown race and 109 applicants who were hired into non-laborer positions.

[2]The Middletown analysis excludes 205 applicants of unknown race and 284 applicants who withdrew during the hiring process.

## Table 2.a
## Analysis of the Racial Composition of Middletown
## All Applications Referred for Background Check and Ashland Hires
## Applications Submitted August 12, 2001 - December 31, 2003

| Location | Total Number of Applications with Known Race | Number of African-American Applications | Percent African-American Among Applications | Total Number Referred (Hired) | Expected Number of African-American Referred (Hired) | Actual Number of African-American Referred (Hired) | Difference Between Actual and Expected | Binomial Number of Standard Deviations |
|---|---|---|---|---|---|---|---|---|
| Ashland[1] | 1,080 | 49 | 4.54% | 115 | 5.22 | 9 | 3.78 | 1.69 |
| Middletown[2] | 4,125 | 367 | 8.90% | 728 | 64.77 | 57 | -7.77 | -1.01 |
| | | | | 843 | 69.99 | 66 | -3.99 | -0.50 |

[1]The Ashland analysis excludes 45 duplicate applications, 821 applications submitted by individuals of unknown race and 109 applications submitted by individuals who were hired into non-laborer positions.

[2]The Middletown analysis excludes 205 applications submitted by individuals of unknown race and 281 applications that were withdrawn prior to the background check.

## Table 2.b
## Analysis of the Racial Composition of Middletown
## Applications Referred for Background Check and Ashland Hires
## Applications Submitted August 12, 2001 - December 31, 2003
## One Application Per Applicant

| Location | Total Number of Applicants with Known Race | Number of African-American Applicants | Percent African-American Among Applicants | Total Number Referred (Hired) | Expected Number of African-American Referred (Hired) | Actual Number of African-American Referred (Hired) | Difference Between Actual and Expected | Binomial Number of Standard Deviations |
|---|---|---|---|---|---|---|---|---|
| Ashland[1] | 1,006 | 46 | 4.57% | 115 | 5.26 | 9 | 3.74 | 1.67 |
| Middletown[2] | 3,789 | 340 | 8.97% | 724 | 64.97 | 55 | -9.97 | -1.30 |
| | | | | 839 | 70.23 | 64 | -6.23 | -0.78 |

[1]The Ashland analysis excludes 789 applicants of unknown race and 109 applicants who were hired into non-laborer positions.

[2]The Middletown analysis excludes 205 applicants of unknown race and 250 applicants who withdrew during the hiring process.

Group

**APPENDIX A**

**Tallahassee, FL**
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# MARY DUNN BAKER

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## PROFESSIONAL EXPERIENCE:

**ERS Group**
- Director (December 1998 to present)
- Vice President and Senior Research Economist (1986 – November 1998)

Design and conduct statistical analyses of economic issues and the valuation of economic losses with emphasis in the area of labor economics. Present expert testimony regarding statistical analysis of employment practices and estimates of economic losses before federal and state courts and in other judicial settings. Develop and implement systems to monitor employment practices. Plan, organize and present seminars on the use of economics and statistics in employment discrimination cases.

**Florida State University**
- Adjunct Professor of Economics (1988-1991)

Courses taught: Intermediate Microeconomic Theory and Principles of Microeconomics

**Auburn University at Montgomery**
- Instructor of Economics (1984-1986)

Courses taught: Principles of Economics I and II and Contemporary Economic Problems

**Florida Public Service Commission**
- Planning and Research Economist, Communications Department (1984)

Analysis of issues in managing the transition to deregulation in the telecommunications industry. Presented recommendations before the Commission.

**Florida State University, Department of Economics**
- Graduate Instructor (1981-1984)

Courses taught: Economics I and II

**Auburn University at Montgomery**
- Instructor of Economics (1976-1981)

Courses taught: Concept of Business, Principles of Economics I and II, Labor Economics, Money and Banking, History of Economic Thought and Comparative Economic Systems

## EDUCATION:

Ph.D., Florida State University, Economics, 1986

M.S. Auburn University, Economics, 1977

B.A. Auburn University, Political Science/Economics, 1974

Education (Cont.)

HONORS AND AWARDS:

Alpha Lambda Delta (Freshman Women)
Omicron Delta Epsilon (Economics)
Pi Sigma Alpha (Political Science)
Phi Kappa Phi
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Labor, Regulated Industries, Natural Resources Economics

## OTHER PROFESSIONAL ACTIVITIES:

Consultant to Hazards Management Group, Inc. Developed residential property valuation model for potentially hazardous areas.

## PUBLICATIONS AND RESEARCH PAPERS:

Compensation Analysis," Chapter 10 in The Human Resources Program Evaluation Handbook, edited by Jack E. Edwards, John C. Scott and Nambury S. Raju, Sage Publications, 2003.

Estimating Economic Damages in Employment Discrimination Cases," Getting to Verdict: Trying Employment Claims to the Jury, The Florida Bar Labor and Employment Law Section, September 15, 1995.

Economic and Statistical Evidence of Employment Discrimination," The Burden of Proof in Trial of an Employment Case, The Florida Bar Labor and Employment Law Section, September 27, 1991.

Issues Surrounding the Reagan Tax Cuts," Alabama Business and Economic Reports, Center for Business and Economic Research, Auburn University at Montgomery, October 1981, pp. 32-34.

Rising Inflation Reduces Police Pay," (with Ken McCreedy), Alabama Peace Officers Journal, January - February 1981, pp. 18-22.

Social Security - A Summary Outlook," Alabama Business and Economic Reports, Center for Business and Economic Research, Auburn University at Montgomery, July 1980, pp. 2-13.

Social Security and the Decline in Labor Force Participation of Older Men," (Abstract), Journal of Alabama Academy of Science, April 1978, p. 94.

## PRESENTATIONS/PROFESSIONAL MEETINGS:

Pay Check Envy: The New Frontier in Employment Litigation," invited speaker at Stearns Weaver Miller's Fifteenth Annual Seminar on Labor & Employment Law, Miami, Florida, May 11, 2005.

Demystifying Compensation Analysis: Analyzing Pay in the Regulatory Environment," invited speaker at the Huntsville Alabama Industry /OFCCP Liaison Group's April 22, 2005 seminar.

Using Statistics to Support and Defend Adverse Impact Age Discrimination Claims," invited speaker at the Regional meeting of the ABA-EEO Committee for Liaison with EEOC, OFCCP and DOJ, New Orleans, Louisiana April 20, 2005.

**Presentations/Professional Meetings (Cont.)**

Demystifying Compensation Analysis," invited speaker at the South Florida Industry/OFCCP Liaison Group's December 7, 2004 seminar.

Commonly Used Statistical Techniques for Analyzing Selections" and "Analyzing Compensation," invited speaker at the U.S. Department of Labor's Employment Standards Administration Office of Federal Contract Compliance Programs' Western Regions' Training Conference, Tucson, Arizona, November 19, 2003.

The Use and Abuse of Statistics in Employment Discrimination Cases," invited speaker at the Regional Meeting of the ABA-EEO Committee for Liaison with EEOC, OFCCP and DOJ, New Orleans, Louisiana, June 19, 2002.

Preparing For and Responding To OFCCP Salary Audits," invited speaker at the 2001 Aerospace Employment Law Conference, Denver, Colorado, November 29, 2001.

The Use of Statistical Evidence in Employment Discrimination Litigation," invited panel member at the American Bar Association's Section on Labor and Employment Law, Equal Employment Opportunity Committee's Mid-Winter Meeting, Sanibel Island, Florida, March 29, 2001.

Statistical Analyses of Compensation," Lorman Education Services' Seminar, Affirmative Action Compliance in Florida, Tallahassee, Florida, March 16, 2001.

Detecting And Understanding Pay Disparities," invited speaker at the 19th Annual Corporate Counsel Institute Atlanta, Georgia, December 7, 2000.

"Detecting and Measuring Pay Disparities: Statistical Analyses of Compensation," Economic Research Services seminar on Pay Equity: The New Discrimination Frontier, Atlanta, Georgia, October 27, 2000.

Statistical Analysis of Employment Practices – Selections and Compensation," Lorman Education Services' Seminar, Affirmative Action Compliance In Alabama, Birmingham, Alabama, September 28, 2000.

Pay Equity Analysis in the New Millennium," invited speaker at Jacksonville Industry Liaison Group's Seminar, Business and Government: A Strategic Alliance for 2000, Jacksonville, Florida, May 23, 2000

The Use of Experts in Employment Cases," invited speaker at The University of Alabama School of Law Conference on Employment Law for Government and Public Sector Lawyers, New Orleans, Louisiana, November 1999.

Salary Analyses -- OFCCP and Alternative Methods," O'Melveny & Myers' Seminar, OFCCP Targets Wall Street New York, New York, February 4, 1999.

Choosing an Age Break: A Discussion of the Issues and an Alternative to Traditional Analyses of Age Discrimination," with Joshua Gotkin, paper presented at the Southern Economic Association Annual Conference. Washington, D.C., 1996.

Estimating Economic Damages in Employment Discrimination Cases," invited speaker at Getting to Verdict: Trying Employment Claims to the Jury, The Florida Bar, Continuing Legal Education Committee and The Labor and Employment Law Section, Orlando, Florida, 1995.

The Use of Statistics in Discrimination Cases," invited speaker at Investing in Human Resources, 1995 Human Resource Development/Personnel Management Conference, Florida Department of Management Services, Tampa, Florida, 1995.

Use and Abuse of Statistics in Employment Claims," invited speaker at Current Issues in Employment Law, Professional Education Systems, Inc., Daytona Beach and Tampa, Florida, 1995.

Methodologies for Determining Economic Damages or Possible Exposure in Employment Discrimination Cases " Economic Research Services, Inc.'s seminar on Economic and Statistical Analysis of Employment Discrimination 1995-1998.

Presentations/Professional Meetings (Cont.)

Statistical Analyses of Employment Practices in a Recent Innovative Consent Decree," paper presented at the Southern Economic Association Annual Conference, Orlando, Florida, 1994.

Dollars and Sense: Quantifying and Managing Employment Decisions," invited speaker at The American Association of Affirmative Action, Region IV Conference, Savannah, Georgia, 1994.

Commonly Used Statistical Techniques" and "Methods of Analyzing Compensation," ERS Group's seminar on Economic and Statistical Evidence of Employment Discrimination: 1992-2004.

Economic and Statistical Evidence of Employment Discrimination," invited speaker at The Florida Bar Employment Law Litigation Seminar, Orlando, Florida, 1991.

The Current and Future State of the Florida Economy," invited speaker at Tomorrow's Trends Today: An Economic Symposium, Sarasota, Florida, 1988.

The Economic Impact of Fixed Facilities on Residential Communities," invited speaker at the Hazardous Materials Advisory Council Semi-Annual Conference, Orlando, Florida, 1987.

Property Values and Potentially Hazardous Production Facilities," paper presented at American Association of Geographers Annual Meeting, Portland, Oregon, 1987.

## PROFESSIONAL ASSOCIATIONS AND MEMBERSHIPS:

American Economic Association

Southern Economic Association

National Association of Forensic Economists

Committee on the Status of Women in the Economics Profession

Auburn University MBA Advisory Board

Auburn University College of Business Advisory Board

Group

**APPENDIX A**

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## DEPOSITION AND COURTROOM TESTIMONY
## 2001 - 2005

American Association of University Professors v. University of Cincinnati, Gender Pay Equity Dispute, FMCS No. 52 390 001512 00 (2000). [deposition, testimony]

Stephen K. Chen, v. MCI Worldcom; United States District Court, Eastern District of Tennessee at Knoxville, Civil Action No. 3:99-CV-322. [deposition]

John Pneuc, et al., v. Continental Micronesia, Inc., and Continental Airlines, Inc.; Superior Court of Guam, Civil Case No. CV69-96. [deposition]

Robert Cram v. Karsten Manufacturing Corporation; United States District Court, District of Arizona, Case No. CIV 00-1128 PHX RCB. [deposition]

Frank Minton v. American Bankers Insurance Group, et al.; United States District Court, Southern District of Florida, Miami Division, Case No. 00-3376-CIV-Seitz/Bandstra. [deposition]

Sharon Pollard v. E.I. Du Pont de Nemours Company; United States District Court, Western District of Tennessee, Westerr Division, Case No. 98-2147 MIA. [deposition]

Curtis Major, et al., v. Eller Media Company; United States District Court, Southern District of Florida, Miami Division, Case No. 00-3870-CIV-MORENO/DUBE. [deposition]

Eugene F. Koren, et al., v. SUPERVALU Inc, and Preferred Products, Inc.; United States District Court, District of Minnesota, Civil No.00-1479 (PAM/JGL). [deposition]

Sylvester McClain, et al., v. Lufkin Industries, Inc.; United States District Court for the Eastern District Court of Texas, Lufkin Division, Civil Action No. 9:97-CV-063. [deposition]

Kimberly Farrow v. Bank of America Corporation; United States District Court, Middle District of Florida, Orlando Division Case No. 6:02-CV-936-OR-28-KRS. [deposition, testimony]

Rhonda Thomas v. Deloitte Consulting, United States District Court, Northern District of Texas, Dallas Division, Case No. 3:02-CV-0343-M. [testimony]

Thaddeus M. Korbin v.Public Service Company of New Mexico; United States District Court for the District of New Mexico, Case No. CV-03-1167 MV/MLT. [deposition]

Revised March 10, 2005

# APPENDIX B

Census 2000 Special EEO Tabulation
EEO-1 Job Categories by Race/Ethnicity, Gender and Geographic Area
Hamilton-Middletown, OH PMSA

| Gender | Recorded Labor Force | Total | Caucasian | Minority | African American | Hispanic | Asian or Pacific Is | American Indian | Balance |
|---|---|---|---|---|---|---|---|---|---|
| **Officials and Managers (1)** | | | | | | | | | |
| Total: | 19,503 | 19,492 | 18,170 | 1,322 | 714 | 124 | 379 | 75 | 30 |
| | | *100.00%* | *93.22%* | *6.78%* | *3.66%* | *0.64%* | *1.94%* | *0.38%* | *0.15%* |
| Male: | | 12,618 | 11,885 | 733 | 360 | 69 | 239 | 35 | 30 |
| | | *64.73%* | *60.97%* | *3.76%* | *1.85%* | *0.35%* | *1.23%* | *0.18%* | *0.15%* |
| Female: | | 6,874 | 6,285 | 589 | 354 | 55 | 140 | 40 | 0 |
| | | *35.27%* | *32.24%* | *3.02%* | *1.82%* | *0.28%* | *0.72%* | *0.21%* | *0.00%* |
| **Professionals (2)** | | | | | | | | | |
| Total: | 31,360 | 31,350 | 28,425 | 2,925 | 1,265 | 365 | 1,050 | 145 | 100 |
| | | *100.00%* | *90.67%* | *9.33%* | *4.04%* | *1.16%* | *3.35%* | *0.46%* | *0.32%* |
| Male: | | 14,555 | 13,045 | 1,510 | 565 | 175 | 630 | 85 | 55 |
| | | *46.43%* | *41.61%* | *4.82%* | *1.80%* | *0.56%* | *2.01%* | *0.27%* | *0.18%* |
| Female: | | 16,795 | 15,380 | 1,415 | 700 | 190 | 420 | 60 | 45 |
| | | *53.57%* | *49.06%* | *4.51%* | *2.23%* | *0.61%* | *1.34%* | *0.19%* | *0.14%* |
| **Technicians (3)** | | | | | | | | | |
| Total: | 4,055 | 4,052 | 3,785 | 267 | 160 | 28 | 75 | 0 | 4 |
| | | *100.00%* | *93.41%* | *6.59%* | *3.95%* | *0.69%* | *1.85%* | *0.00%* | *0.10%* |
| Male: | | 1,548 | 1,440 | 108 | 65 | 8 | 35 | 0 | 0 |
| | | *38.20%* | *35.54%* | *2.67%* | *1.60%* | *0.20%* | *0.86%* | *0.00%* | *0.00%* |
| Female: | | 2,504 | 2,345 | 159 | 95 | 20 | 40 | 0 | 4 |
| | | *61.80%* | *57.87%* | *3.92%* | *2.34%* | *0.49%* | *0.99%* | *0.00%* | *0.10%* |
| **Sales Workers (4)** | | | | | | | | | |
| Total: | 18,890 | 18,903 | 17,580 | 1,323 | 710 | 134 | 340 | 90 | 49 |
| | | *100.00%* | *93.00%* | *7.00%* | *3.76%* | *0.71%* | *1.80%* | *0.48%* | *0.26%* |
| Male: | | 9,543 | 8,955 | 588 | 355 | 19 | 130 | 65 | 19 |
| | | *50.48%* | *47.37%* | *3.11%* | *1.88%* | *0.10%* | *0.69%* | *0.34%* | *0.10%* |
| Female: | | 9,360 | 8,625 | 735 | 355 | 115 | 210 | 25 | 30 |
| | | *49.52%* | *45.63%* | *3.89%* | *1.88%* | *0.61%* | *1.11%* | *0.13%* | *0.16%* |
| **Administrative Support Workers (5)** | | | | | | | | | |
| Total: | 28,790 | 28,794 | 26,665 | 2,129 | 1,530 | 265 | 195 | 95 | 44 |
| | | *100.00%* | *92.61%* | *7.39%* | *5.31%* | *0.92%* | *0.68%* | *0.33%* | *0.15%* |
| Male: | | 6,679 | 6,250 | 429 | 290 | 90 | 25 | 20 | 4 |
| | | *23.20%* | *21.71%* | *1.49%* | *1.01%* | *0.31%* | *0.09%* | *0.07%* | *0.01%* |
| Female: | | 22,115 | 20,415 | 1,700 | 1,240 | 175 | 170 | 75 | 40 |
| | | *76.80%* | *70.90%* | *5.90%* | *4.31%* | *0.61%* | *0.59%* | *0.26%* | *0.14%* |

# APPENDIX B

**Census 2000 Special EEO Tabulation**
**EEO-1 Job Categories by Race/Ethnicity, Gender and Geographic Area**
**Hamilton-Middletown, OH PMSA**

| Gender | Recorded Labor Force | Total | Caucasian | Minority | African American | Hispanic | Asian or Pacific Is | American Indian | Balance |
|---|---|---|---|---|---|---|---|---|---|
| **Craft Workers (6)** | | | | | | | | | |
| Total: | 16,345 | 16,347 | 15,130 | 1,217 | 575 | 384 | 75 | 169 | 14 |
| | | *100.00%* | *92.56%* | *7.44%* | *3.52%* | *2.35%* | *0.46%* | *1.03%* | *0.09%* |
| Male: | | 15,480 | 14,355 | 1,125 | 515 | 380 | 55 | 165 | 10 |
| | | *94.70%* | *87.81%* | *6.88%* | *3.15%* | *2.32%* | *0.34%* | *1.01%* | *0.06%* |
| Female: | | 867 | 775 | 92 | 60 | 4 | 20 | 4 | 4 |
| | | *5.30%* | *4.74%* | *0.56%* | *0.37%* | *0.02%* | *0.12%* | *0.02%* | *0.02%* |
| **Operatives (7)** | | | | | | | | | |
| Total: | 22,120 | 22,114 | 19,790 | 2,324 | 1,410 | 340 | 335 | 170 | 69 |
| | | *100.00%* | *89.49%* | *10.51%* | *6.38%* | *1.54%* | *1.51%* | *0.77%* | *0.31%* |
| Male: | | 16,344 | 14,760 | 1,584 | 965 | 225 | 210 | 130 | 54 |
| | | *73.91%* | *66.75%* | *7.16%* | *4.36%* | *1.02%* | *0.95%* | *0.59%* | *0.24%* |
| Female: | | 5,770 | 5,030 | 740 | 445 | 115 | 125 | 40 | 15 |
| | | *26.09%* | *22.75%* | *3.35%* | *2.01%* | *0.52%* | *0.57%* | *0.18%* | *0.07%* |
| **Laborers and Helpers (8)** | | | | | | | | | |
| Total: | 6,845 | 6,848 | 6,110 | 738 | 280 | 304 | 45 | 90 | 19 |
| | | *100.00%* | *89.22%* | *10.78%* | *4.09%* | *4.44%* | *0.66%* | *1.31%* | *0.28%* |
| Male: | | 5,924 | 5,250 | 674 | 260 | 300 | 20 | 90 | 4 |
| | | *86.51%* | *76.66%* | *9.84%* | *3.80%* | *4.38%* | *0.29%* | *1.31%* | *0.06%* |
| Female: | | 924 | 860 | 64 | 20 | 4 | 25 | 0 | 15 |
| | | *13.49%* | *12.56%* | *0.93%* | *0.29%* | *0.06%* | *0.37%* | *0.00%* | *0.22%* |
| **Service Workers (9)** | | | | | | | | | |
| Total: | 21,985 | 21,985 | 19,460 | 2,525 | 1,640 | 295 | 325 | 190 | 75 |
| | | *100.00%* | *88.51%* | *11.49%* | *7.46%* | *1.34%* | *1.48%* | *0.86%* | *0.34%* |
| Male: | | 8,085 | 7,150 | 935 | 620 | 100 | 125 | 65 | 25 |
| | | *36.78%* | *32.52%* | *4.25%* | *2.82%* | *0.45%* | *0.57%* | *0.30%* | *0.11%* |
| Female: | | 13,900 | 12,310 | 1,590 | 1,020 | 195 | 200 | 125 | 50 |
| | | *63.22%* | *55.99%* | *7.23%* | *4.64%* | *0.89%* | *0.91%* | *0.57%* | *0.23%* |
| **Unemployed, No Civilian Work Experience Since 1995 (10)** | | | | | | | | | |
| Total: | 470 | 467 | 385 | 82 | 60 | 14 | 4 | 0 | 4 |
| | | *100.00%* | *82.44%* | *17.56%* | *12.85%* | *3.00%* | *0.86%* | *0.00%* | *0.86%* |
| Male: | | 270 | 210 | 60 | 50 | 10 | 0 | 0 | 0 |
| | | *57.82%* | *44.97%* | *12.85%* | *10.71%* | *2.14%* | *0.00%* | *0.00%* | *0.00%* |
| Female: | | 197 | 175 | 22 | 10 | 4 | 4 | 0 | 4 |
| | | *42.18%* | *37.47%* | *4.71%* | *2.14%* | *0.86%* | *0.86%* | *0.00%* | *0.86%* |

# APPENDIX B

**Census 2000 Special EEO Tabulation**
**EEO-1 Job Categories by Race/Ethnicity, Gender and Geographic Area**
**Hamilton-Middletown, OH PMSA**

| Gender | Recorded Labor Force | Total | Caucasian | Minority | African American | Hispanic | Asian or Pacific Is | American Indian | Balance |
|---|---|---|---|---|---|---|---|---|---|
| **Total Civilian Labor Force** | | | | | | | | | |
| Total: | 170,360 | 170,352 | 155,500 | 14,852 | 8,344 | 2,253 | 2,823 | 1,024 | 408 |
| | | *100.00%* | *91.28%* | *8.72%* | *4.90%* | *1.32%* | *1.66%* | *0.60%* | *0.24%* |
| Male: | | 91,046 | 83,300 | 7,746 | 4,045 | 1,376 | 1,469 | 655 | 201 |
| | | *53.45%* | *48.90%* | *4.55%* | *2.37%* | *0.81%* | *0.86%* | *0.38%* | *0.12%* |
| Female: | | 79,306 | 72,200 | 7,106 | 4,299 | 877 | 1,354 | 369 | 207 |
| | | *46.55%* | *42.38%* | *4.17%* | *2.52%* | *0.51%* | *0.79%* | *0.22%* | *0.12%* |

## Notes

1. The total Civilian Labor Force shown for each Census Detailed Occupation category may differ from the Total Count due to the rounding scheme employed by the Census Bureau in construction of the file to protect individual's privacy. For details see "Appendix 5: Protecting Privacy, Census 2000 Special Tabulation Technical Documentation".

2. The race/ethnicity groupings are constructed according to guidance provided by the EEOC in, "Introduction to Race and Ethnic (Hispanic Origin) Data for the Census 2000 Special EEO File".

Caucasian: White not Hispanic or Latino.

Minority: Total minus White not Hispanic or Latino.

African American: Black or African American not Hispanic or Latino, plus Black or African American and White not Hispanic.

Hispanic: White Hispanic or Lation plus Other Hispanic or Latino.

Asian: Asian not Hispanic or Lation plus Asian and White not Hispanic or Latino.

American Indian: American Indian or Alaska Native not Hispanic or Latino, plus American Indian or Alaska Native and White not Hispanic or Latino.

Pacific Islander: Native Hawaiian or Other Pacific Islander not Hispanic or Latino.

Balance: American Indian or Alaska Native and Black or African American not Hispanic or Latino, plus balance of individuals reporting more than one race not Hispanic or Latino, plus individuals reporting some other race not Hispanic or Latino.

Source: Census 2000 Special EEO Tabulation, File 4: Civilian Labor Force 16 years and older: EEO-1 Job Categories by Race/Ethnicity and Sex. Sponsored by Equal Employment Opportunity Commission, Department of Justice, Department of Labor, Office of Federal Contract Compliance Program and Office of Personnel Management. Prepared by U.S. Census Bureau. Issued February, 2004.

## Appendix C
## Percent Black Among Laborers and Helpers (EEO-1 Category 8)

| State | County | Percent of Ashland's Current Union Employees Who Reside in County, State | Total Number of Laborers & Helpers | Number of Black Laborers & Helpers | Percent Black Among Laborers & Helpers |
|---|---|---|---|---|---|
| KY | BOYD | 32.66% | 988 | 14 | 1.42% |
| | CARTER | 6.19% | 999 | 0 | 0.00% |
| | FLEMING | 0.10% | 447 | 34 | 7.61% |
| | GREENUP | 26.27% | 823 | 8 | 0.97% |
| | JOHNSON | 0.30% | 609 | 0 | 0.00% |
| | LAWRENCE | 1.93% | 408 | 0 | 0.00% |
| | LEWIS | 1.01% | 569 | 0 | 0.00% |
| | ROWAN | 0.10% | 650 | 0 | 0.00% |
| OH | ADAMS | 0.10% | 911 | 0 | 0.00% |
| | GALLIA | 0.10% | 712 | 30 | 4.21% |
| | LAWRENCE | 20.39% | 1365 | 15 | 1.10% |
| | SCIOTO | 3.45% | 1842 | 14 | 0.76% |
| WV | CABELL | 2.64% | 1890 | 110 | 5.82% |
| | LINCOLN | 0.61% | 639 | 0 | 0.00% |
| | MINGO | 0.10% | 417 | 0 | 0.00% |
| | PUTNAM | 0.20% | 1039 | 4 | 0.39% |
| | WAYNE | 3.85% | 928 | 0 | 0.00% |

Source: Census 2000 Special EEO Tabulation, File 4: Civilian Labor Force 16 years and older: EEO-1 Job Categories by Race/Ethnicity and Sex. Sponsored by Equal Employment Opportunity Commission, Department of Justice, Department of Labor, Office of Federal Contract Compliance Program and Office of Personnel Management. Prepared by U.S. Census Bureau. Issued February, 2004.

APPENDIX D

# USE OF STATISTICS IN EQUAL EMPLOYMENT OPPORTUNITY LITIGATION

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**APPENDIX D**





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# APPENDIX D



## § 11.11 One Tail or Two? Or Does It Really Matter?

### [1]—Introduction

The District of Columbia Circuit in *Palmer v. Schultz*[1] wrote one of the most lucid descriptions extant of the statistical standards of proof a court expects from a plaintiff. The court begins its discussion with a description of the statistical method for testing hypotheses, and from there weaves in the concepts of one- and two-tailed tests and their associated probability or p-values. It goes on to assert that "a court should generally adopt a two-tailed approach to evaluating the probability that the contested disparity resulted by chance" and that "statistical evidence must meet the 5% level . . . for it alone to establish a prima facie case. . . ."[2] The court then asserts that "a two-tailed test and a 5% probability of randomness require statistical evidence measuring 1.96 standard deviations" and that "if plaintiffs come into court relying *only* on evidence that the under selection of women for a particular job measures 1.75 standard deviations, it seems improper for a court to establish an inference of disparate treatment on the basis of this evidence alone."[3]

This clearest-yet statement of a statistical standard of proof is a great service to litigants, enabling them better to evaluate their positions before trial. But the wording of the standard seems to imply that one-tailed tests are not proper vehicles for setting forth a statistical case, and perhaps even to imply that all statistical test results should be expressed on the standard deviation scale for ready comparison to the 1.96 threshold. This is unfortunate, and almost surely unintended. It seems likely that the true intent of the court was to hold that a two-tailed test should be interpreted against a 5% probability threshold, that a one-tailed test should be interpreted against a threshold of 2.5%, and, when used with these interpretations, the tests are equally

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[1] Palmer v. Schultz, 43 F.E.P. Cases 452 (D.C. Cir. 1987).

[2] *Id.* at 465.

[3] *Id.* See also:

*Sixth Circuit:* Dobbs-Weinstein v. Vanderbilt University, 1 F. Supp. 2d 783, 808 (M.D. Tenn. 1998), *aff'd* 185 F.3d 542 (6th Cir. 1999) (noting that a one-tailed test makes it easier to claim statistically significant evidence of discrimination, since a probability level of 0.5 under a two-tailed analysis translates into 1.96 standard deviations, while under a one-tailed analysis it becomes just 1.65 standard deviations).

*District of Columbia Circuit:* Moore v. Summers, 113 F. Supp. 2d 5, 20 n.2 (D.D.C. 2000) (since purpose of Title VII is to assure that people are treated equally, not that one group is treated at least as well as or better than another, District of Columbia Circuit prefers two-tailed tests).

satisfactory. It also seems likely that, given the opportunity, the court would make it clearer that its 1.96 standard deviation threshold applies only to certain kinds of random variables.

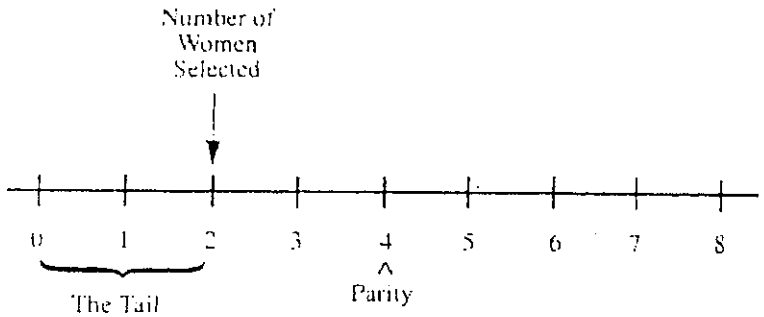
### [2]—Statistical Theory of One- and Two-Tailed Tests

There are two commonly used ways to express the results of the test of a statistical hypothesis. The first of these uses probabilities, and the second uses standard deviations. The first of these two methods itself has two variations: the one-tailed probability and the two-tailed probability. The key distinction is that one-tailed analysis measures whether a particular group is disfavored, while two-tailed analysis tests whether the group is either preferred or disfavored.[3.1] The salient features of these methods can be conveyed by examples in which a group of people has been chosen from a much larger group called the pool, and the gender composition of the group selected is contrasted with that of the pool to determine whether the process appears to have favored the selection of men to the disadvantage of women.

#### [a]—The One-Tailed Probability

The one-tailed probability is the probability that random selection from the large pool would result in the group having as few or fewer

**Figure 11.3 The One-Tailed Test**

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[3.1] *Sixth Circuit*: *Debbie Wernstein v. Vanderbilt University*, N. 3 *supra*, 1 F. Supp. 2d at 805 (finding that one-tailed analysis was not appropriate in wage discrimination case).

*District of Columbia Circuit*: Hartman v. Duffey, 88 F.3d 1232, 1238 (D.C. Cir. 1996); Moore v. Summers, 113 F. Supp. 2d 5, 20 n.2 (D.D.C. 2000) (explaining that one-tailed test "reveals whether blacks are treated at least as well as or better than

## APPENDIX D



women that it in fact contains. For example, suppose the group contains 8 people, of whom 2 are women, and suppose half of the members of the pool are women. The one-tailed probability is the probability that if 8 people were drawn randomly from the pool, no more than 2 of them would be women. The notion of a tail (see Figure 11.3) arises from the observation that this probability is the sum of the three individual probabilities that the pool might contain, respectively, 2, 1 and 0 women, and that these probabilities pertain to the most extreme (the tail) of the possible outcomes of a random draw. The usefulness of the one-tailed probability (as well as the two-tailed probability) as a measure of imbalance derives from the fact that a small probability value indicates an imbalance of so great a magnitude that it cannot reasonably be attributed to the luck of the draw.

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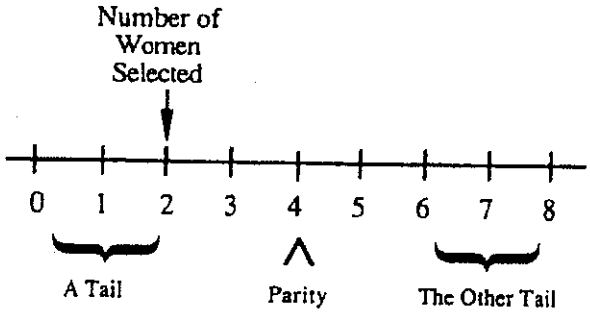
whites, but does not indicate whether whites are treated worse than blacks; two-tailed test demonstrates whether blacks and whites were treated equally, taking into account both whether whites are treated as well as or better than blacks and vice versa).

**[b]—The Two-Tailed Probability.** The two-tailed probability is the probability that if the group were drawn randomly from the pool, the composition of the group would differ *in any sense* by as much or more than it in fact does from that of the pool. Continuing the above example, the two-tailed probability is the probability that if 8 people were drawn randomly from the pool, the number of women among them would be 2 or less or else 6 or more (see Figure 11.4). The underlying rationale is that since half of the pool members are women, a random draw of 8 people is as likely to yield 3 women as 5; to yield 2 women as 6; 1 woman as 7; and so forth. Hence the group's imbalance of 2 women in 8 is just as extreme as an imbalance of 6 women in 8, and less extreme than the imbalance in groups containing 7 or 8 women. By this mode of thought, there are two types of extemes (hence two tails) to consider: the possibilities that a random draw would yield 2, 1 or 0 women, and the possibilities that it would yield 6, 7 or 8 women.

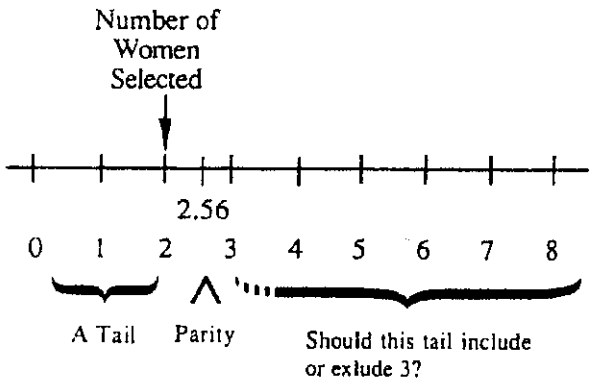
Figure 11.4 The Two-Tailed Test




It is clear from the symmetry of this example that the two-tailed probability is exactly twice the numerical value of the one-tailed probability. Hence whether one reports the degree of imbalance in the example as a one-tailed probability makes little difference, because the recipient of the information can easily convert from one to the other. That is, neither measure of imbalance contains either more or less information than does the other. It is important, of course, to indicate the number of tails on which the reported probability is based.

In the absence of such symmetry, the definition of the two-tailed test may be ambiguous. Suppose for example that 32% (instead of 50%) of the pool members are women. The one-tailed probability[4] (.501) is still the probability that 2 or fewer of the 8 people selected randomly would be women, but it is not clear how one should define the antipodal tail. Perfect parity is 32% of 8, or 2.56 women out of 8. The difference between 2.56 and the number (2) of women in the group is 0.56 women, so perhaps the antipodal threshold should be 2.56 + .56 = 3.12 women. Hence an imbalance of 3.12 or more women (that is, 4 or more) would be considered comparable to an imbalance of 2 or fewer women. By this definition, the two-tailed probability is 0.733. Alternatively, we might note that the probability (0.499) of selecting 3 or more women is nearly the same as (but slightly less than) the probability (0.501) of selecting 2 or fewer women, and on this basis regard an imbalance of 3 or more women to be comparable to an imbalance of 2 or fewer women. By this definition, the two-tailed probability is 0.499 + 0.501 = 1.00, not 0.733 (see Figure 11.5).

Figure 11.5 The One-Tailed Test: Asymmetric Case




This illustrates that different criteria exist for the definition of a two-tailed probability, and that they can lead to different numerical values for the two-tailed probability. In view of this, it is also apparent that a two-tailed probability need not be equal to twice the one-tailed probability.

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[4] The calculation of this probability and others to follow is somewhat involved, and the details are not presented here. The calculations are based on the well-known binomial statistical model.

**[c]—The Standard Deviation Scale.** The standard deviation method for expressing disparities is an alternative to the probability methods. Unlike probabilites, which take values between 0 and 1 (or 0% and 100%), a disparity measured on the standard deviation scale can be any positive or negative number. In the example of the selection of 8 people from a pool containing equal numbers of men and wome, the group having 2 or more women among the 8 is a certain number of standard devitions away from perfectly reflecting the gender composition of the pool. There is no sense in which this disparity is one-or two-tailed; one simply states that having 2 women in the group of 8 is a certain number of standard deviations below the perfect parity figure of 4.[5]

**[d]—Discussion.** As the above examples show, a given disparity can sometimes be expressed as a one-tailed probability, a two-tailed probability, and a number of standard deviations. Unfortunately, there is no formula by means of which one can always convert among these measures, because their relationships depend on the specific nature of the probabilities governing the slection process, as well as the definition chosen for the two-tailed probability. However, if the selection probabilities are such that the number of women selected is a so-called normal random variable, then a standard conversion holds: a two-tailed probability is twice the corresponding one-tailed probability, a two-tailed probability of 5% corresponds to a 1.96 standard deviation disparity, and (therefore) a one-tailed probability of 2.5% also corresponds to a 1.96 standard deviation disparity. If the number of women drawn is not a normal random variable (and it is not in any of the examples above), then these relationships need not and often do not hold.

Statisticians generally prefer to use the probability measures of disparity because they are directly comparable across a wide variety of situations. In contrast, a disparity of, say, two standard devia-

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[5] The standard deviation in this case is calculated using a binomial model:

$$\text{standard deviation} = \sqrt{(8 \times .5 \times .5)} = 1.414.$$

Hence the number of standard deviations by which 2 differs from 4 is $(4 - 2)/1.414 = 1.414$.

tions can in some circumstances be rather improbable as a consequence only of chance, and in others, highly probable.[6]

### [3]—Discrimination Litigation Conventions.

In many of the published opinions regarding the use of statistics in discrimination litigation the attention of the court has been focused on a random variable that is normal, or nearly so.[7] Consequently, it has made little difference whether the court couched its opinion in terms of one- or two-tailed probabilities, or in numbers of standard deviations, because as long as the units of denomination were clear, the recipient of the information could freely convert to his or her preferred scale.

Indeed, the court of appeals in *Palmer v. Schultz* shifted freely among all three measures in its discussion. But when it fixed the minimal probability threshold (5%) it thought most appropriate, it happened to be thinking in terms of two-tailed probabilities, and it failed to emphasize that the one-tailed equivalent of that threshold is 2.5%.[8] Likewise, when it translated the 5% two-tailed probability threshold into the 1.96 standard deviation threshold, it failed to emphasize that this translation only holds for certain kinds of random variables, most notably the normal random variables.[9] Conse-

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[6] For example, if a single draw from a pool of people of whom 80% are women results in the selection of a man, a disparity of two standard deviations exists between the composition of the group selected (just one person) and that of the pool. But there is evidently one chance in five (a probability of 20%) of this imbalance occurring when the selection is random. This is substantially larger than the 2.3% probability (one chance in 44) to which two standard deviations corresponds for a normal random variable. Or consider a third situation: A random variable that can take any value between 0 and 1 with equal probability has an average or perfect parity value of .5, and a standard deviation of .289. The greatest amount by which this variable can differ from its perfect parity value is (1-.5)/.289 = 1.73 standard deviations. Hence it is impossible (probability = 0%) for this random variable to register a value as large as two on the standard deviation scale.

[7] See Castaneda v. Partida, 430 U.S. 482, 97 S.Ct. 1272, 51 L.Ed.2d 498 (1977); Hazelwood School District v. United States, 433 U.S. 299, 307, 97 S.Ct. 2736, 53 L.Ed.2d 768 (1977); Palmer v. Schultz, 43 F.E.P. Cases at 460 (D.C. Cir. 1987).

[8] At 43 F.E.P. Cases at 465, n.9, the court does clearly acknowledge the equivalence of a one-tailed probability of 2.5% and a two-tailed probability of 5%. Its failure to mention the equivalence explicitly in its main statement of the standard for a statistical *prima facie* case therefore seems due to its choice of organization for its written opinion, rather than its intent to favor two-tailed probabilities over one-tailed probabilities.

[9] Again, in n.9, *Id.*, the court explicitly recognizes the equivalence of 1.96 standard

quenlty, the reader of *Palmer v. Schultz* is likely to conclude (1) that two-tailed probabilities are always more appropriate than one-tailed probabilities, and (2) that regardless of the underlying probability model, 1.96 standard deviations is an appropriate minimal threshold against which to judge a disparity on the standard deviation scale. A more logical interpretation of this court's view is that it matters not whether a litigant uses a one- or a two-tailed probability, so long as it is used in conjunciton with the appropriate threshold probability: 5% for two-tailed probabilities, and 2.5% for one-tailed probabilities. Furthermore, as long as one is dealing with a normal random variable, one may use a third (completely equivalent) alternative the standard deviation scale along with a threshold of 1.96 standard deviations.

But if one is not dealing with a normal random variable, is the 1.96 standard deviation threshold still appropriate? Not necessarily. The 1.96 number arises in the context of normal random variables *because* it is equivalent to a one-tailed probability of 2.5% and to a two-tailed probability of 5%, and it is not of itself a particularly notworthy or appropriate threshold. For non-normal random variables, therefore, it seems most appropriate to recalibrate the standard deviation scale to determine the threshold which corresponds either to a one-tailed probability of 2.5% or, in cases in which there is no material ambiguity in its definition, to a two-tailed probability of 5%.

Under this interpretation of the intent of the court of appeals in *Palmer*, litigants are free to use one-tailed probabilities, two-tailed probabilities, or standard deviation tests, whichever seem best to fit the fact situation, as long as these various measures of disparity are measured against the proper thresholds for significance.

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deviations with both a one-tailed probability of 2.5% and a two-tailed probability of 5%. Since the court's discussion is confined to normal random variables (see 43 F.E.P. Cases at 462), however, it is never compelled to note that for other kinds of random variables, 1.96 standard deviations may not even approximate a one-tailed probability of 2.5% or a two-tailed probability of 5%.

APPENDIX E

# The Statistics of Discrimination

Using Statistical Evidence in Discrimination Cases

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## APPENDIX E



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This latter example illustrates a constraint on avoiding Type I errors. By adopting a standard that minimizes the number of Type I errors, the chance of identifying discrimination when it actually occurs is reduced. That is, the possibility that we would fail to reject the null hypothesis even though it was in fact not true is increased. This type of error, failing to reject X when in fact it is not true, is called a *Type II error*.[22] In our last example, using the 1 percent standard for Type I error, a court would not infer that Employer A had discriminated even though, if Employer A had truly not discriminated, one would see this hiring outcome (10 women hired) in fewer than one case out of 20. Thus, the possibility of Type II errors is a constraint on our ability to set strict standards to avoid Type I errors. In the context of discrimination law, for example, we want both (1) to avoid inferences of discrimination when, in fact, the employer did not discriminate (Type I errors) and yet, (2) to avoid failing to make an inference of discrimination when, in fact, the employer did discriminate (Type II errors). Since the goals are in conflict, pursuit of either goal limits pursuit of the other.[23]

## §2.05 The Problem of Causation

Causation is particularly important in discrimination cases and requires careful delineation of statistical and legal meanings.[24] In discrimination cases, the ultimate concern is with what causes disparities between two groups. In our systemic disparate treatment example, for instance, liability depends on the cause of the disparity between the proportion of women hired by the employer and the proportion of women in the applicant pool. Was the disparity caused by the employer's intention to discriminate (in which case the employer would be liable)? Or was it caused by other factors?[25]

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[22] The relationship between Type I and Type II errors is complex, but, if all other factors are held constant, decreasing the risk of Type I errors increases the risk of Type II errors and vice versa. *See* Michael O. Finkelstein & Bruce Levin, Statistics for Lawyers 186-188 (1990). *See also* the discussion of statistical power in §4.15.

[23] A common way to reduce the possibility of both types of error is to increase the sample size. In most discrimination cases, that option is not available, so the conflict becomes more salient.

[24] For a discussion of other tensions between statistical and legal meanings, *see* §2.06.

[25] Causation issues are also important in disparate impact cases. Consider, for example, a case in which a test appears to screen out a higher proportion of women than men. The first issue will be whether the test actually does cause the apparent disparity between male and female pass rates. If the difference in pass rates is large and based on a large sample, statistical analysis may indicate that the difference would have been quite unlikely to occur by chance. Thus, an inference that the

For two basic reasons, however, statistical inference can never *prove*[26] a cause for a disparity.[27] First, statistical inference cannot prove the cause of a disparity, because it provides information only on the likelihood of particular outcomes. In our example, for instance, statistical inference provided information about how often one would observe 10 women hired if the employer repeatedly hired 100 people randomly from an applicant pool consisting of 20 percent women. Statistical analysis indicated only—no more, no less—that one would rarely see as few as 10 women hired under those circumstances. It did not prove that discrimination caused the outcome; the employer could have hired without discrimination and been that one case out of 20 in which as few as 10 women were hired. Indeed, even if the employer had hired no women, statistical analysis would not prove that the employer discriminated; the employer could have been that extremely rare case in which random hiring resulted in no women hired. A fact-finder may (and should) be more willing to infer that discrimination caused a disparity as the employer's hiring outcome becomes less and less likely to have occurred by chance, but the inference of causation is the fact-finder's. Statistical analysis only provides information on how likely it is that the outcome can be explained by other factors, such as chance.[28]

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test truly does have an adverse impact on women may be appropriate. On the other hand, if the difference in pass rates is small and/or based on a small sample, statistical analysis may indicate that the apparent disparity very likely was caused by chance. As a result, a fact-finder may be unwilling to infer that the test truly has an adverse impact on women. In either case, of course, the causation issue of interest, whether the test actually causes a difference in male and female pass rates, cannot be proven or disproven by statistical inference. Rather, statistical inference can be used only to evaluate the likelihood that the disparity occurred by chance. For detailed discussion, *See* §§5.05-5.10.

[26] Here, of course, "prove" is used to mean "establish conclusively" in the sense in which a mathematician or logician might use the word when verifying results. "Prove" is not used in the legal sense of "sufficient to justify a particular result." The courts have recognized time and time again that statistical methods are capable of proving discrimination in the legal sense.

[27] Some readers may recall that David Hume made quite a name for himself on a stronger, but closely analogous point:

> [W]e never can, by our utmost scrutiny, discover any thing but one event following another, without being able to comprehend any force or power by which the cause operates, or any connexion between it and its supposed effect.

David Hume, Enquiries Concerning the Human Understanding and Concerning the Principles of Morals 73-74 (LA Selby-Bigge ed 2d ed 1902 Clarendon Press) (1777).

[28] Our example focused on chance as the explanatory variable, other than discrimination, which might explain the disparity. Later in this volume, techniques that can

## APPENDIX E

Statistical analysis cannot prove the cause of a disparity for another reason as well: statistics cannot eliminate the possibility that factors other than those considered by the analysis may have caused the disparity. In our example, statistical analysis indicated that it was unlikely that chance caused the disparity between the proportion of women hired and the proportion in the applicant pool. One remaining possibility is that discrimination caused the disparity, but it is only one of the remaining possibilities. The employer might claim, for example, that it only hired people who possessed a certain legitimate job qualification, X, and that a higher proportion of male applicants than female applicants possessed X. If the employer's claim is true, rejecting chance as a likely cause of the disparity may not be sufficient to justify an inference of discrimination. The disparity may have been caused by X rather than sex discrimination. The plaintiffs could certainly use statistical techniques (or other types of evidence) to evaluate this employer claim as well, but even if they successfully demonstrate that it is unlikely the disparity was caused by X *and* chance, an infinity of other possible causes for the disparity exists. A fact-finder's inference of discrimination becomes stronger as the statistical evidence (or other evidence) renders unlikely more and more of the plausible alternative explanations for the disparity. But no analysis can consider all of the alternative explanations. As a result, because the logic of statistical analysis operates negatively by rejecting possible causative factors, statistical analysis can never affirmatively prove discrimination.

These formal limitations on the ability of statistical analysis to prove causation are mentioned because they highlight the underlying logic of statistical analysis. At the same time, however, legal proof is considerably different from the rigorous proof required by mathematics or formal logic. The courts have clearly and correctly recognized that statistical analysis alone can be sufficient to prove causation in a legal sense[29] despite its limitations in proving causation in a more rigorous sense. And the courts have recognized that the statistical analysis itself need not be perfect to have these legal consequences.[30] At the end of the day, of course, the relevant standard for evaluating statistical methods is not whether they meet the standards of mathematics or formal logic, but whether they meet the requirements of legal proof.[31]

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be used to analyze the likelihood that other variables, such as job tenure or qualifications, resulted in particular outcomes will be discussed. *See* chs 4, 5, and 6.

[29] *See* Teamsters v United States, 431 US 324, 339 (1977).

[30] Bazemore v Friday, 478 US 385 (1986).

[31] In a very real sense, the requirements of legal proof are what this book is about: What degree of statistical rigor is required of plaintiffs when establishing a prima facie case through statistical evidence? What is required of defendants who object to the statistical analyses of plaintiffs or who forward their own statistical analyses? What weight should courts place on imperfect statistical analyses?